Pickup unit comprising a stroke limiter, and disk drive unit provided with such a pickup unit

FIELD OF THE INVENTION

The invention relates to a pickup unit for reading and/or writing data on a disk, comprising a stroke limiter limiting the stroke of any movement of the movable part in the pickup unit.

BACKGROUND OF THE INVENTION

One of the problems of such pickup units is that the stroke of the movable part in the pickup unit is so big that this movable part may hit adjacent parts of the pickup unit or the disk, which may damage the disk or optical or mechanical components of the pickup unit.

One embodiment of a pickup unit in which it is attempted to solve the problem is known from EP 1 124 223 A.

EP 1 124 223 A discloses a pickup unit in which the movable part is placed on the base such that the stroke of any movement of the movable part in the tracking direction is limited by two upright wall portions provided on the base so as to surround the movable part. The range of movement of the movable part in the focusing direction is restricted by a stopper member. Thus, this pickup unit provides a mechanical system for limiting the stroke.

Alternatively, there are known pickup units in which the problem of an excessive stroke of the movable part is attempted to be solved by using signals from the optics and electronics of the pickup unit to sense an excessive stroke and provide a signal to the actuator in order to effect a counter force on the movable part so as to return it to a central position.

It is an object of the present invention to provide a pickup unit having a novel stroke limiter.

SUMMARY OF THE INVENTION

In order to accomplish that objective, the pickup unit according to the invention comprises the features of claim 1.

In the pickup unit according to claim 1, the stroke limiter comprises an electrical contact which is operatively connected to the actuator to cause the actuator to move

the movable part or allow it to move towards a central position upon closure of the contact. The advantage of this system is that this stroke limiter enables a fast operation of the pickup unit as the movable part is quickly brought back to within its normal range of movement by the actuator or the at least one elastic support member. As a result, the operation of the pickup unit is continued quickly, thereby preventing any disturbance of the operation of the disk drive. However, the system according to the invention is not dependent on the optical system of the disk drive or on the presence of a disk with which the optical system cooperates.

Although the invention can be useful in limiting the movement of the movable part in one direction, the embodiment of claim 2 is preferred since it minimizes the risk of damage to the pickup unit and disk.

A preferred embodiment of the pickup unit according to the invention is defined in claim 3.

According to this embodiment, a mechanical and electrical stop is combined, so that the movable part of the pickup unit may both be mechanically stopped and be brought back to its operational range. Preferably, the mechanical stop is combined with the electrical contact to simplify the construction of the stroke limiter.

A simple embodiment of the stroke limiter according to the invention is defined in claim 4, while it is preferred to combine it with the feature of claim 5, so that the electrical and mechanical contact are effected by the counter member.

If the feature of claim 6 is used in the pickup unit, the stroke limiter will be adjustable so as to precisely adjust the stroke limiter to the particular pickup unit. In this way, tolerances may be compensated for.

A very simple embodiment is defined in claim 7. In this embodiment, an existing member of a pickup unit is used as one of the parts of the stroke limiter, so that only an additional counter member is necessary.

It is favorable in this embodiment to use the feature of claim 8, since the elastic support member is electrically conducting anyway in many existing pickup units.

The stroke limiter according to the invention may be integrated in existing pickup unit designs without many adaptations. In new designs, it may be preferable to use the feature of claim 12 as this will bring the point of contact closer to the center of mass of the movable part of the pickup unit. This leads to a more favorable absorption of forces when the stroke limiter becomes active. This will improve the accuracy of the stroke limiter. The same is true for the embodiment of claim 13.

A favorable embodiment for the electric circuit is defined in claim 14. In this embodiment, the movable part will be brought back to its central position by the elastic force of the elastic support member. This arrangement provides not only a mechanical but also an electrical protection of the device. If there is a software failure resulting in the lens holder being urged into an extreme position by a continuing failure signal, a removal of the electrical potential from the coils will prevent the coils from being burned out and may be used to rest the software. Additionally or alternatively, the movable part is actively returned to its central position by the actuator under control of the processing unit.

The invention also relates to a disk drive unit comprising the pickup unit as described above.

These and other aspects and advantages of the invention will be apparent from the following description with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a simplified perspective view of a preferred embodiment of a pickup unit for a disk drive unit according to the invention.

Fig. 2 is a perspective view of the pickup unit of Fig. 1, as seen from the other side.

Fig. 3 is an enlarged view of detail III in Fig. 1.

Fig. 4 is a view corresponding to that of Fig. 3, but showing an alternative embodiment of the pickup unit according to the invention.

Fig. 5 is a smaller scale sketch of a disk drive including the pickup unit according to the invention.

Fig. 6 shows a very schematic electrical circuit used in the pickup unit as shown in figs. 1-5 to allow return of a movable part of the pickup unit to a central position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings show a preferred embodiment of a pickup unit 1 according to the invention. This pickup unit may be used in a device for reading and/or writing data on a disk, such as a compact disk player, which is adapted for reading/and or writing disks for audio, video, and/or data by means of an optical, magnetic, or the like reading and/or writing member.

Fig. 5 shows such a disk drive unit including a motor 20 and spindle 21, as well as an optical system 22 including the pickup unit 1 for reading/writing the data

from/onto a disk D. In Fig. 5, the disk D is shown as being accommodated in an optional cartridge C which is inserted into the drive unit. The disk D has its clamping area engaged by the spindle 21 of the motor 20 in order to be driven. The lens of the pickup unit 1 is positioned very close to the disk 1 when inserted.

In an (optical) disk for use in this disk drive unit, data is encoded in one or more layers of the disk. Various principles are known, each variant being suitable for use in conjunction with the invention. The data is laid down in one or more data tracks in digital form. The variations of (optical) properties along the data tracks contain the data recorded on the disk. To read and/or write the data on the disk, the latter is rotated by means of a disk drive motor. The disk is read and/or written by detection of the variations of (optical) properties along the data tracks by the pickup unit. In the presently preferred embodiment according to the invention, the variations are detected by means of laser light emitted from and reflected back to the pickup unit.

With reference to Figs. 1 - 4, the preferred embodiments of the pickup unit 1 comprise a lens (to be mounted in hole 2) as a reading and/or writing member mounted to a movable part, in this case a lens holder 3. The lens holder 3 is connected to a base 4 of the pickup unit 1 by means of four rectilinear wire members 5 which are made of a resilient, preferably electrically conductive material, such as copper, iron, or an alloy. In this manner, the wire members 5 form elastic support members for suspending the lens holder 3 in a steady (pre-biased) position when no external force is exerted on the lens holder 3, and allowing the lens holder 3 to be slightly moved with respect to the base 4 when a force is applied to the lens holder 3.

The pickup unit 1 as a whole is movable in a tracking direction y with respect to the disk by means of a slide mechanism (not shown). An actuator 6, 7, 8 (see Fig. 4, in Figs. 1 – 3 it is omitted) provided between the lens holder 3 and the base 4 can move the lens 2 of the pickup unit 1 with respect to the disk and the base 4 in the tracking direction y and in a focusing direction z and can tilt it about a tangential axis x.

In the preferred embodiment of the pickup unit 1, the actuator 6, 7, 8 comprises a plurality of permanent magnets 9 connected to the base 4 and a plurality of coils 10 connected to the lens holder 3 and positioned opposite the respective permanent magnets 9, such that the coils 10 and the permanent magnets 9 exert forces on the lens holder 3 by means of electric currents through the coils 10. The movement of the lens holder 3 with respect to the base 4 and the disk is used to focus the laser light on the exact point on the data track in the disk, and to position the lens holder 3 in such a way with respect to the disk that

the laser light is always locally perpendicular to the surface of the disk, despite an inclination of the surface of the disk caused by deviations in the flatness of the surface of the disk.

To accurately control the position and orientation of the lens holder 3 of the preferred embodiment of the pickup unit 1, the electric currents through the coils 10 are provided by a control circuit (not shown). In order to determine the actual position of the lens holder 3 with respect to the disk, the control circuit may use, for example, intensity parameters of the laser light received by the pickup unit 1. The control unit is not considered part of the invention and a multitude of possible implementations of a control circuit for this purpose are known, so that no further description is given of the control unit.

The lens holder 3 carrying the lens 2 is adapted to be positioned at a very small operating distance to the surface of the disk, typically 150 μm to 1 mm, and is also positioned close to the permanent magnets 9. A sudden large movement of or vibrations in the pickup unit may cause the lens holder 3 to strike against the disk or the magnets, which may lead to damage of the lens holder 3, lens 2, and/or disk.

According to the invention, there is provided a stroke limiter 11, in this case comprising a limiter plate 12 attached to the base 4 in a position close to the lens holder 3. The limiter plate extends substantially perpendicularly to the wire support members 5 which extend through holes 13 in the limiter plate 12. These holes 13 have dimensions/diameter such that there is a free space or clearance around the wire members 5 which determines the freedom of movement of the wire members 5 at the location of the limiter plate 12 (see also Fig. 3). This determines the free stroke of the lens holder 3 in the various directions. The dimensions of the holes 13 are selected such that the lens holder will not be able to hit the magnets 10 and will also be limited in the focusing direction to prevent or diminish the risk of hitting the disk. The limiter plate 12 or some other stroke-limiting member may be adjustable to compensate for tolerances between the lens holder 3 and the base 4. The holes 13 may be square, rectangular, round, or any other shape that would cause a desired limitation of the stroke of the lens holder in the required directions. The holes may surround the wire members completely or only partly. In fact, in the embodiment shown, the corner portions of limiter plate 12 may be removed so as to create a notch or recess, so that the holes 13 may have only two sides adjacent the respective wire member 5. The various holes limit the movements of the respective wire members 5 in different directions so that the holes 13 complement each other and together limit the movement of the lens holder 3 in all directions.

The wire members 5 are conducting, and this property is used to contact the stroke limiter. The counter member, in this case the limiter plate 12, is also at least partly

electrically conducting and connected such that a contact between one or more of the wire members 5 with the limiter plate 12 will effect, for example, a short-circuit situation or a reverse current or a reset signal such that the actuator 6, 7, 8 will be deactivated or actuated to exert a return force on the lens holder 3 to move it back to its central position, or at least to within its operating range. This will bring the lens holder quickly to within its operating "in focus" range so that, when the pickup unit is in operation, it can quickly regain its proper operation.

Fig. 6 shows a simple electrical circuit designed to ensure that the lens holder 3 ill return to its central position when the contact is activated. The circuit incorporates coils 10' and 10" for actuating the lens holder 3 in the focusing and tracking directions. Respective leads 23' and 23" run through the wire members 5 and are connected through respective amplifiers 24', 24" to a processor unit. The limiter plate 12 acts as a ground contact, and at least one of the wire members 5 will act as a short-circuit switch 25 the moment it contacts the limiter plate 12. In that case, the electric potential across the coils 10', 10" is removed so that there is no actuating force on the lens holder 3 anymore. The lens holder 3 will then be allowed to return to its central position under the elastic force exerted upon it by the wire members 5. As an additional measure, it would be conceivable to program the software of the processor unit such that a short-circuit situation, which will be detected in the processor unit, is followed by an active control signal to the coils 10', 10" to urge the lens holder 3 to its central position.

This arrangement provides not only a mechanical but also an electrical protection of the device. If there is a software failure resulting in the lens holder 3 being urged into an extreme position by a continuing failure signal, the removal of the electrical potential from the coils 10', 10" will prevent the coils from being burned out and may be used to reset the software.

Fig. 4 shows an alternative embodiment in which the limiter plate 11 comprises an additional hole 14 co-operating with a protruding pin 15 provided on the lens holder 3. These co-operating pin and hole act as a stroke limiter at least in two directions, whereas the tilting movements are limited by the co-operation between the wire members 5 and holes 13. Preferably, the pin 15 extends substantially through the center of mass of the lens holder 3 to limit moments of inertia on the lens holder when the movement of the lens holder is limited by the limiter plate 12. Ideally, the stroke limiter would have an effective point of engagement exactly in the center of mass of the lens holder.

It may be gathered from the foregoing description that the pickup unit 1 according to the invention provides a simple and effective stroke limiter for the pickup unit of a disk drive.

The invention is not restricted to the above-described embodiment as shown in the drawings, which may be varied in several ways without departing from the scope of the invention.

For example, the elastic support members may have any kind of shape between their mounting positions, and they may each have a different bending stiffness, as long as the center of stiffness of the wire members coincides with the center of mass of the lens holder. The number of elastic support members is accordingly not limited to four; the pickup unit may, for example, also be provided with six elastic support members arranged in two cooperating groups of support members instead of two cooperating pairs of support members.

As a further example, the mounting positions of the elastic support members of each cooperating pair at the lens holder and the base may be spaced apart by equal distances and in the same direction in any direction to obtain the (dynamic) properties of the movement of the lens holder as stated above.

In another variation, the elastic support members may extend at a slight angle to a plane through the lens in the focusing direction and the tangential direction.

It is noted that, in the specification and claims, the use of the expressions "a" or "an" does not exclude a plurality of the respective items, and the expression "comprising" does not exclude additional elements or steps. Reference signs in the claims shall not be construed as limiting the scope thereof. A single processor or unit may fulfil the functions of several elements in the appended claims.

In the presently preferred embodiments, the disk is an optical data disk. However, it should be understood that the invention may also be used for all kinds of other disks e.g. ferro-electric, magnetic, magneto-optical, near-field, active charge storage disks, or other disks using combinations of these techniques or other reading and/or writing techniques. In these cases the lens will be replaced by some other reading/writing member.

The invention is not limited to the embodiments shown in the drawing and described hereinbefore, which may be varied in different manners within the scope of the appended claims. For example, the stroke limiter may comprise a protrusion mounted to the base and a counter member mounted to the lens holder. In all embodiments, the parts of the

stroke limiter may be completely electrically conducting or comprise contacts and conductors to provoke a desired signal or current upon closure of the contact in the stroke limiter.

If the elastic support members are attached to projecting portions of the movable part, they may be extended beyond the projecting portions by means of extensions. These extensions may co-operate with the counter member and thus function as a stroke limiter which is positioned closer to the center of mass of the movable part of the pickup unit.